Missouri Department of Transportation

Bridge Division

Bridge Design Manual

Section 2.4

Revised 04/04/2005

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Index of Standard Details

2.4.9 Welding Details

ANSI/AASHTO/AWS D1.5

All welding shall be detailed in accordance with ANSI / AASHTO / AWS D1.5, Bridge Welding Code. See **Figure 2.4.9-2** to **Figure 2.4.9-10** for standard welding symbols.

AASHTO 10.32.2

For ASTM A709, Grade 36 steel (Service Load Design F_u = 58,000 psi) the allowable shear stress in fillet welds (F_V) is:

$$F_V = 0.27\ F_u$$

where

F_V = allowable basic shear stress;

F_u = tensile strength of the electrode classification but not greater than the tensile strength of the connected part.

Allowable Shear Loads for Fillet Welds *

Size of Fillet Weld (Inch)	**Allowable Shear Loads per Length** (Pound per lineal inch)
1/8”	1,380
3/16”	2,075
1/4"	2,770
5/16”	3,460
3/8”	4,150
1/2"	5,535
5/8”	6,920
3/4"	8,300
7/8”	9,690
1”	11,070

* Allowable Shear Load = (0.27)(58000 psi)(0.707xSize of Weld)(L)
where: L = Effective Length, in inch
(0.707xSize of Weld) = Effective Throat, in inch
(0.707xSize of Weld)(L) = Effective weld area in sq. inch

2.4.11 Development and Splicing of Reinforcement

2.4.11.1 General

Development of Tension Reinforcement

AASHTO 8.25

Development lengths for tension reinforcement shall be calculated in accordance with AASHTO Article 8.25. Development length modification factors described in AASHTO Articles 8.25.3.2 and 8.25.3.3 shall only be used in situations where development length without these factors is difficult to attain. All other modification factors shown shall be used.

Development lengths for tension reinforcement have been tabulated on the following pages and include the modification factors except those described above.

Lap Splices of Tension Reinforcement

AASHTO 8.32

Lap splices of reinforcement in tension shall be calculated in accordance with AASHTO Article 8.32.1 and 8.32.3. Class C splices are preferred when possible, however it is permissible to use Class A or B when physical space is limited. The designer shall satisfy AASHTO Table 8.32.3.2 when using Class A or B splices. It should be noted that As required is based on the stress encountered at the splice location, which is not necessarily the maximum stress used to design the reinforcement.

ACI 318R-89 7.12.2.3

Temperature and shrinkage reinforcement is assumed to fully develop the specified yield stresses. Therefore the development length shall not be reduced by (A_S required)/(A_S supplied).

Splice lengths for tension reinforcement have been tabulated on the following pages and include the development length modifications as described above.

Development of Tension Hooks

AASHTO 8.29

Development of tension hooks shall be calculated in accordance with AASHTO Article 8.29. Hook length modification factors described in Articles 8.29.3.3 and 8.29.3.4 shall only be used in situations where hook length without these factors is difficult to attain. All other modification factors shown shall be used.

Development lengths of tension hooks have been tabulated on the following pages and include the modification factors except those described above.

Development of Compression Reinforcement

AASHTO 8.26

Development lengths for compression reinforcement shall be calculated in accordance with AASHTO Article 8.26. Development length modification factors described in AASHTO Articles 8.26.2.1 and 8.26.2.2 shall only be used in situations where development length without these factors is difficult to attain. All other modification factors shown shall be used.

Development lengths for compression reinforcement have been tabulated on the following pages and include the modification factors except those described above.

Lap Splices of Compression Reinforcement

AASHTO 8.32

Lap splices of reinforcement in compression shall be calculated in accordance with AASHTO Article 8.32.1 and 8.32.4.

Splice lengths for compression reinforcement have been tabulated on the following pages.

Mechanical Bar Splices

AASHTO 8.32.2

Mechanical bar splices may be used in situations where it is not possible or feasible to use lap splices. Mechanical bar splices shall meet the criteria of AASHTO Article 8.32.2. Refer to the manufacturers literature for more information on the design of mechanical bar splices.

2.4.11.2. Development and Tension Lap Splice Lengths - Top Bars (Fy = 60 ksi)

TOP BARS

Step 1	Step 2	Step 3	Step 4	Step 5								
		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11
< 6" on center or < 3" clear cover (direction of spacing) 	NON-EPOXY	3 ksi	L_d	13	17	21	28	37	49	62	78	96
			B	17	22	28	36	48	63	80	102	125
			C	22	29	36	47	63	82	105	133	163
		4 ksi	L_d	13	17	21	26	32	42	54	68	83
			B	17	22	28	33	42	55	70	88	108
			C	22	29	36	43	55	71	91	115	142
	EPOXY 1 (<$6d_b$ clear spacing or <$3d_b$ cover any direction) 	3 ksi	L_d	16	21	26	33	45	59	75	95	117
			B	20	27	34	43	59	77	97	123	152
			C	27	35	44	56	77	100	127	161	198
		4 ksi	L_d	16	21	26	31	39	51	65	82	101
			B	20	27	34	40	51	66	84	107	131
			C	27	35	44	53	66	87	110	139	172
	EPOXY 2 (all other situations)	3 ksi	L_d	15	20	25	32	43	56	71	90	111
			B	19	26	32	41	56	73	92	117	144
			C	25	33	42	53	73	95	120	152	188
		4 ksi	L_d	15	20	25	29	37	48	62	78	96
			B	19	26	32	38	48	63	80	101	125
			C	25	33	42	50	63	82	104	132	163
≥6" on center and ≥3" clear cover (direction of spacing) 		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11
	NON-EPOXY	3 ksi	L_d	12	14	17	22	30	39	50	63	77
			B	16	18	22	29	39	51	64	81	100
			C	21	23	29	37	51	66	84	106	131
		4 ksi	L_d	12	14	17	21	26	34	43	54	67
			B	16	18	22	27	34	44	56	70	87
			C	21	23	29	35	44	57	73	92	113
	EPOXY 1 (<$6d_b$ clear spacing or <$3d_b$ cover any direction) 	3 ksi	L_d	13	17	21	27	36	47	60	76	94
			B	16	22	27	35	47	61	78	99	121
			C	21	28	35	45	61	80	102	129	159
		4 ksi	L_d	13	17	21	25	32	41	52	66	81
			B	16	22	27	32	41	53	68	85	105
			C	21	28	35	42	53	69	88	112	137
	EPOXY 2 (all other situations)	3 ksi	L_d	12	16	20	25	34	45	57	72	89
			B	16	21	26	33	45	58	74	93	115
			C	21	27	33	43	58	76	96	122	150
		4 ksi	L_d	12	16	20	24	30	39	49	62	77
			B	16	21	26	31	39	50	64	81	100
			C	21	27	33	40	50	66	84	106	130

Top reinforcement is placed so that more than 12" of concrete is cast below the reinforcement.
Class A splice =1.0 L_d, Class B splice =1.3 L_d, Class C splice =1.7 L_d
Use development and tension lap splices of f'c = 4 ksi for concrete strengths greater than 4 ksi.

2.4.11.3. Development and Tension Lap Splice Lengths - Other Than Top Bars (Fy = 60 ksi)

NOT TOP BARS

Step 1	Step 2	Step 3	Step 4	Step 5								
		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11
< 6" on center or < 3" clear cover (direction of spacing) 	NON-EPOXY	3 ksi	L_d	12	12	15	20	27	35	44	56	69
			B	12	16	20	26	35	45	57	73	89
			C	16	21	26	33	45	59	75	95	117
		4 ksi	L_d	12	12	15	18	23	30	38	49	60
			B	12	16	20	24	30	39	50	63	78
			C	16	21	26	31	39	51	65	82	101
	EPOXY 1 (<$6d_b$ clear spacing or <$3d_b$ cover any direction) 	3 ksi	L_d	14	18	23	30	40	52	66	84	103
			B	18	24	30	38	52	68	86	109	134
			C	23	31	39	50	68	88	112	142	175
		4 ksi	L_d	14	18	23	27	35	45	57	73	89
			B	18	24	30	36	45	59	74	94	116
			C	23	31	39	46	59	76	97	123	152
	EPOXY 2 (all other situations)	3 ksi	L_d	12	14	18	23	31	40	51	64	79
			B	14	18	23	29	40	52	66	83	103
			C	18	24	30	38	52	68	86	109	134
		4 ksi	L_d	12	14	18	21	27	35	44	56	69
			B	14	18	23	27	35	45	57	72	89
			C	18	24	30	36	45	59	75	94	116
		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11
≥ 6" on center and ≥ 3" clear cover (direction of spacing) 	NON-EPOXY	3 ksi	L_d	12	12	12	16	22	28	36	45	55
			B	12	13	16	21	28	36	46	58	72
			C	13	17	21	27	36	47	60	76	94
		4 ksi	L_d	12	12	12	15	19	24	31	39	48
			B	12	13	16	19	24	31	40	50	62
			C	13	17	21	25	32	41	52	66	81
	EPOXY 1 (<$6d_b$ Clear spacing or <$3d_b$ cover any direction) 	3 ksi	L_d	12	15	18	24	32	42	53	67	83
			B	15	19	24	31	42	54	69	87	107
			C	19	25	31	40	54	71	90	114	140
		4 ksi	L_d	12	15	18	22	28	36	46	58	72
			B	15	19	24	29	36	47	60	75	93
			C	19	25	31	37	47	61	78	99	121
	EPOXY 2 (all other situations)	3 ksi	L_d	12	12	14	18	25	32	41	52	63
			B	12	15	18	24	32	42	53	67	82
			C	15	19	24	31	42	54	69	87	108
		4 ksi	L_d	12	12	14	17	21	28	35	45	55
			B	12	15	18	22	28	36	46	58	71
			C	15	19	24	29	36	47	60	76	93

Class A splice =1.0 L_d, Class B splice =1.3 L_d, Class C splice =1.7L_d
Use development and tension lap splices of f'c = 4 ksi for concrete strengths greater than 4 ksi.

2.4.11.4. Development and Lap Splice Lengths - Bars in Compression (Fy = 60 ksi)

Step 1	Step 2	Step 3	Step 4	Step 5										
		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11	#14 (*)	#18 (*)
Compression	Development Length	3 ksi	L_d	9	11	14	17	20	22	25	28	31	38	50
			$L_{d,\ spiral}$	8	9	11	13	15	17	19	21	24	28	38
		4 ksi	L_d	8	10	12	15	17	19	22	25	27	33	43
			$L_{d,\ spiral}$	8	8	9	11	13	15	17	19	21	25	33
	Lap Splices (*)	All f'c	Std. Lap	12	15	19	23	27	30	34	39	43	51	68
			With Ties	12	13	16	19	22	25	29	32	36	43	57
			With Spiral	12	12	15	17	20	23	26	29	32	39	51

Development length for spirals, $L_{d,\ spiral}$, should be used if reinforcement is enclosed in a spiral of not less than 1/4" diameter and no more than 4" pitch. See AASHTO 8.26 for special conditions.

All values are for splices with the same size bars. For different size bars, see AASHTO 8.32.4.

(*) Lap splices for #14 and #18 bars are not permitted except as column to footing dowels.

2.4.11.5 Development of Standard Hooks in Tension, L_{dh} (Fy = 60 ksi)

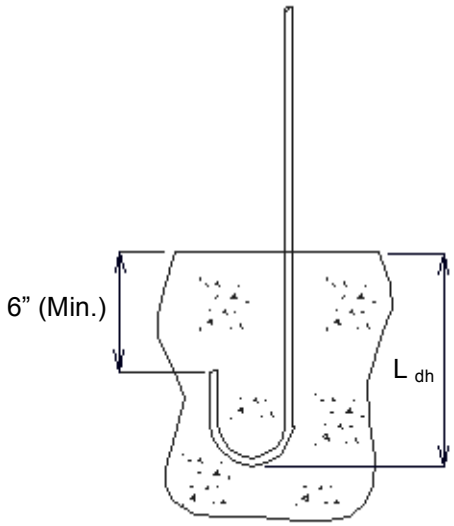
The development length, **L_{dh}**, is measured from the critical section to the outside edge of hook. The tabulated values are valid for both epoxy and non-epoxy coated hooks.

Step 1	Step 2	Step 3	Step 4	Step 5										
		f'c	Bars	#3	#4	#5	#6	#7	#8	#9	#10	#11	#14 (*)	#18 (*)
Hooks in Tension (*)	Case A	3 ksi	Non-Epoxy	9	11	14	17	20	22	25	28	31	38	50
			Epoxy	11	13	17	20	24	26	30	34	37	46	60
		4 ksi	Non-Epoxy	8	10	12	15	17	19	22	25	27	33	43
			Epoxy	10	12	14	18	20	23	26	30	32	40	52
	Case B	3 ksi	Non-Epoxy	6	8	10	12	14	16	18	20	22	38	50
			Epoxy	7	10	12	14	17	19	22	24	26	46	60
		4 ksi	Non-Epoxy	6	7	9	10	12	14	15	17	19	33	43
			Epoxy	7	8	11	12	14	17	18	20	23	40	52
	Min. L_{dh} for 6" (Min.) required at free edge or const. joint			10	11	11	12	13	14	17	18	19	23	29

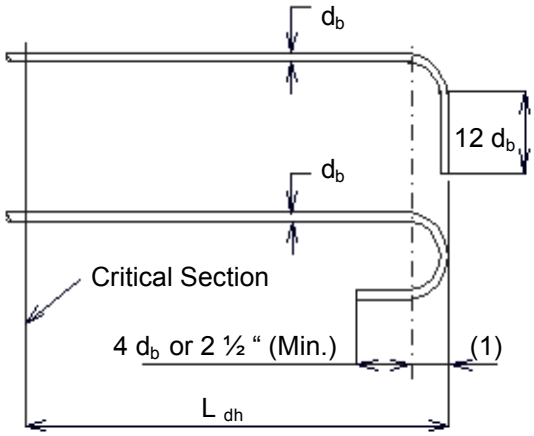
Case A - For #11 bar and smaller, side cover (normal to plane of hook) less than 2-1/2 inches and for a 90 degree hook with cover on the hook extension less than 2 inches.

Case B - For #11 bar and smaller, side cover (normal to plane of hook) greater than 2-1/2 inches and for a 90-dgree hook with cover on the hook extension 2 inches or greater.

(*) See Structural Project Manager before using #14 or #18 hook.



DETAL NEAR FREE EDGE OR CONSTRUCTION JOINT



(1) = $4d_b$ (#3 thru #8)
(1) = $5d_b$ (#9, #10 and #11)
(1) = $6d_b$ (#14 and #18)

HOOKED-BAR DETAILS FOR DEVELOPMENT OF STANDARD HOOKS

2.4.11.6 Development of non-epoxy coated Grade 40 deformed bars in tension, L_d (AASHTO 8.25)

Bars spaced laterally less than 6 inches on center or less than 3 inches concrete cover in direction of the spacing

Bar	f ' c = 3 ksi		f ' c = 4 ksi		f ' c = 5 ksi	
	*L*d	*L*d Top bar	*L*d	*L*d Top bar	*L*d	*L*d Top bar
#3	12	12	12	12	12	12
#4	12	12	12	12	12	12
#5	12	14	12	14	12	14
#6	13	19	12	17	12	17
#7	18	25	16	22	14	20
#8	23	33	20	28	18	25
#9	30	41	26	36	23	32
#10	38	52	33	45	29	41
#11	46	64	40	56	36	50
#14	63	87	54	76	49	68
#18	81	113	70	98	63	88

Bars spaced laterally 6 inches or more on center and at least 3 inches concrete cover in direction of the spacing

Bar	f ' c = 3 ksi		f ' c = 4 ksi		f ' c = 5 ksi	
	*L*d	*L*d Top bar	*L*d	*L*d Top bar	*L*d	*L*d Top bar
#3	12	12	12	12	12	12
#4	12	12	12	12	12	12
#5	12	12	12	12	12	12
#6	12	15	12	14	12	14
#7	15	20	13	18	12	16
#8	19	26	16	23	15	20
#9	24	33	21	29	19	26
#10	30	42	26	36	23	33
#11	37	52	32	45	29	40
#14	50	70	44	61	39	54
#18	65	90	56	78	50	70

2.4.11.7 Minimum lap length for non-epoxy coated Grade 40 tension lap splices, L_{lap} (AASHTO 8.32)

Bars spaced less than 6 inches laterally on center and at least 3 inches concrete cover in direction of the spacing

	Other than Top Bars									Top Bars								
	f 'c = 3 ksi			f 'c = 4 ksi			f 'c = 5 ksi			f 'c = 3 ksi			f 'c = 4 ksi			f 'c = 5 ksi		
Bar	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
#3	12	12	12	12	12	12	12	12	12	12	16	21	12	16	21	12	16	21
#4	12	12	14	12	12	14	12	12	14	12	16	21	12	16	21	12	16	21
#5	12	13	17	12	13	17	12	13	17	14	19	24	14	19	24	14	19	24
#6	13	17	22	12	16	21	12	16	21	19	24	31	17	22	29	17	22	29
#7	18	23	30	16	20	26	14	19	24	25	32	42	22	28	37	20	26	34
#8	23	30	40	20	26	34	18	24	31	33	42	55	28	37	48	25	33	43
#9	30	38	50	26	33	43	23	30	39	41	54	70	36	47	61	32	42	54
#10	38	49	63	33	42	55	29	38	49	52	68	89	45	59	77	41	53	69
#11	46	60	78	40	52	68	36	46	61	64	84	109	56	72	95	50	65	85

Bars spaced 6 inches or more laterally on center and at least 3 inches concrete cover in direction of the spacing

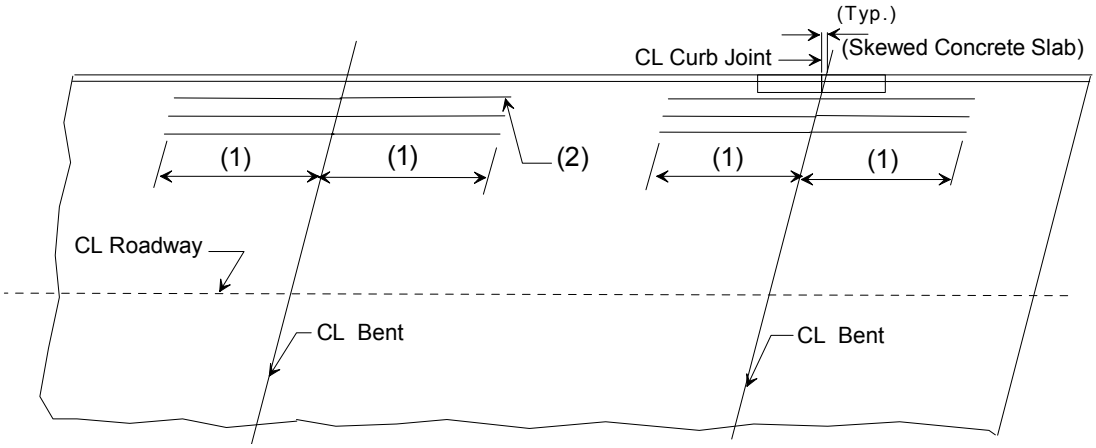
	Other than Top Bars									Top Bars								
	f 'c = 3 ksi			f 'c = 4 ksi			f 'c = 5 ksi			f 'c = 3 ksi			f 'c = 4 ksi			f 'c = 5 ksi		
Bar	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
#3	12	12	12	12	12	12	12	12	12	12	16	21	12	16	21	12	16	21
#4	12	12	12	12	12	12	12	12	12	12	16	21	12	16	21	12	16	21
#5	12	12	14	12	12	14	12	12	14	12	16	21	12	16	21	12	16	21
#6	12	14	18	12	13	17	12	13	17	15	19	25	14	18	23	14	18	23
#7	15	19	24	13	16	21	12	15	20	20	26	34	18	23	29	16	21	27
#8	19	24	32	16	21	28	15	19	25	26	34	44	23	29	38	20	26	34
#9	24	31	40	21	27	35	19	24	31	33	43	56	29	37	49	26	33	44
#10	30	39	51	26	34	44	23	30	39	42	54	71	36	47	62	33	42	55
#11	37	48	63	32	42	54	29	37	49	52	67	87	45	58	76	40	52	68

Note: Design plan details shall indicate splice length.

2.4.12 Miscellaneous

Negative Moment Steel over Intermediate Supports

Dimension negative moment steel over intermediate supports as shown.

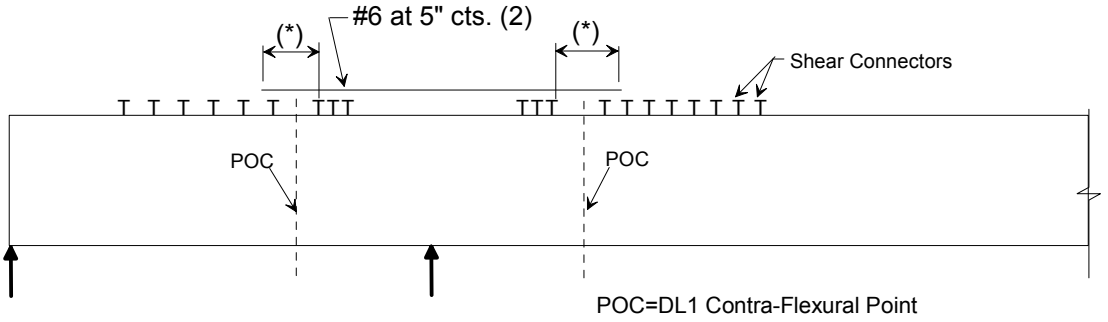


Prestressed Structures:

(1) Bar length by design.
(2) Reinforcement placed between longitudinal temperature reinforcing in top.
Bar size: #5 bars at 7-1/2" cts. (Min.)
#8 bars at 5" cts. (Max.)

Steel Structures:

(1) Extend into positive moment region beyond "Anchor" Stud shear connectors at least **40 x bar diameter x 1.5** (Epoxy Coated Factor)(*) as shown below. (AASHTO 10.38.4.4 & AASHTO 8.25.2.3)
(2) Use #6 bars at 5" cts. between longitudinal temperature reinforcing in top.



(*) 40 x bar diameter x 1.5 = 40 x 0.75" x 1.5 = 45" for #6 epoxy coated bar.

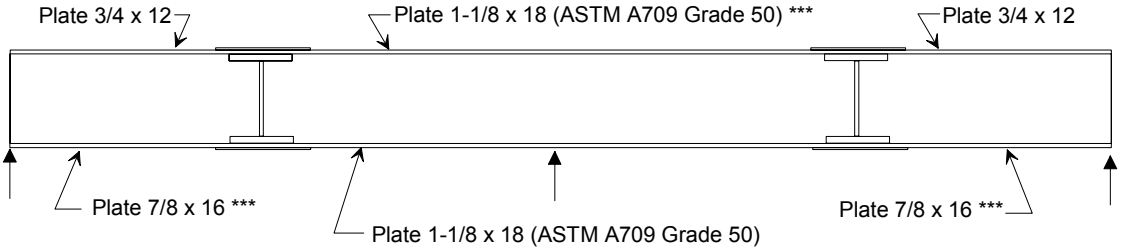
Notch Toughness

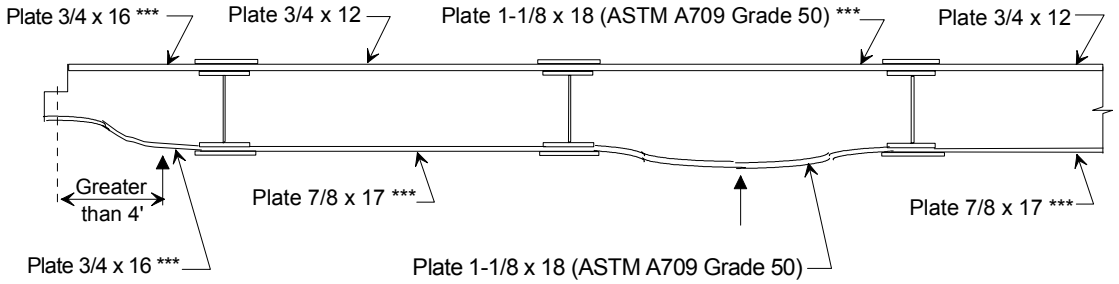
Wide Flange Beams Structures:

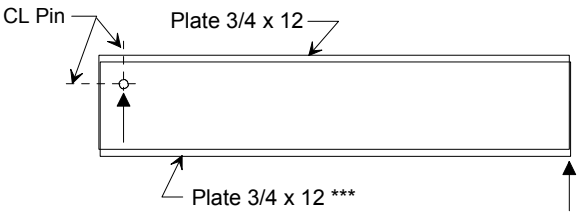
See Section 4, page H1-C, for proper notes to be placed on plans.

Plate Girders Structures:

See Section 4, page H1-C, for proper notes to be placed on plans.
Typical examples for location of *** on plans for tension flange only of plate girders are shown below.







Note:
All web plates are subject to notch toughness.

Other special locations for *** will be for tension flanges of floorbeams in straight girder bridges, and for top and bottom flanges of floorbeams in curved girder bridges.

When any splices are located in a moment area, all flange and web splice plates for the bridge are subject to notch toughness requirements. Show *** with detail of flange splice plate.

*Fracture Control Plan (FCP) **

Fracture Control Plan (FCP), Section 12 of ANSI/AASHTO/AWS D1.5-95, shall apply to fracture critical nonredundant member.

AASHTO LRFD 1.3.4
AASHTO 10.3.1

Main elements and components whose failure is expected to cause the collapse of the bridge shall be designated as failure-critical and the associated structural system as non-redundant. Example of nonredundant members are flange and web plates in one or two girder bridges, main one-element truss members and hanger plates.

AASHTO LRFD 6.6.2.

For non-redundant steel structures or members, the designer shall determine which, if any, component is a Fracture Critical Member (FCM). The location of all FCMs shall be clearly delineated on the design plans.

ANSI/AASHTO/AWS D1.5-95 12.2

FCMs are defined as tension members or tension components of bending members (including those subject to reversal of stress), the failure of which would be expected to result in collapse of the bridge. The designation "FCM" shall mean fracture critical member or member component. Members and components that are not subject to tension stress under any condition of live load are not fracture critical.
Any attachment welded to a tension zone of an FCM shall be considered an FCM when any dimension of the attachment exceeds 4 inches in the direction parallel to the calculated tensile stress in the FCM. Attachments designated FCM shall meet all requirements of FCP.
All welds to FCMs shall be considered fracture critical and shall conform to the requirements of FCP. Welds to compression members or compression area of bending member are not fracture critical.

AASHTO LRFD 6.6.2.

FCMs shall be fabricated in accordance with FCP. Material for FCM shall be tested in accordance with AASHTO T243 (ASTM A673), Frequency P. Material for components not designed as fracture critical shall be tested in conformance with AASHTO T243 (ASTM A673), Frequency H. The Section 712 of the Standard Specification and FCM Special Provisions will include additional requirement for material, welding, inspection and manufacturing.

Notes to be placed on contract plans are as follows:
General Notes:
This structure contains non-redundant Fracture Critical Members (F.C.M.). See Special Provisions for F.C.M. requirements.
Notes for Superstructure - Steel Spans
(Place FCM next to the member or member components)
(Place following notes near the FCM)
FCM indicates Fracture Critical Member, see Special Provisions.
The welds for FCM's are controlled by ANSI/AASHTO/AWS D1.5-95.

The notes may replace the notch toughness requirement now being used. If there are components requiring notch toughness that are not FCM's on the same plans as FCM's both notes will be necessary.

The designation "FCP" shall mean fracture control plan and shall include all provisions of Section 12 AASHTO/AWS Fracture Control Plan (FCP) for Nonredundant Members of ANSI/AASHTO/AWS D1.5-95, Bridge Welding Code.

Decimal Equivalents Table

Decimals of a Foot for Inches and Fractions													
		0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
0.0000"	0"	0.0000	0.0833	0.1667	0.2500	0.3333	0.4167	0.5000	0.5833	0.6667	0.7500	0.8333	0.9167
0.0625"	1/16"	0.0052	0.0885	0.1719	0.2552	0.3385	0.4219	0.5052	0.5885	0.6719	0.7552	0.8385	0.9219
0.1250"	1/8"	0.0104	0.0938	0.1771	0.2604	0.3438	0.4271	0.5104	0.5938	0.6771	0.7604	0.8438	0.9271
0.1875"	3/16"	0.0156	0.0990	0.1823	0.2656	0.3490	0.4323	0.5156	0.5990	0.6823	0.7656	0.8490	0.9323
0.2500"	1/4"	0.0208	0.1042	0.1875	0.2708	0.3542	0.4375	0.5208	0.6042	0.6875	0.7708	0.8542	0.9375
0.3125"	5/16"	0.0260	0.1094	0.1927	0.2760	0.3594	0.4427	0.5260	0.6094	0.6927	0.7760	0.8594	0.9427
0.3750"	3/8"	0.0313	0.1146	0.1979	0.2812	0.3646	0.4479	0.5313	0.6146	0.6979	0.7813	0.8646	0.9479
0.4375"	7/16"	0.0365	0.1198	0.2031	0.2865	0.3698	0.4531	0.5365	0.6198	0.7031	0.7865	0.8698	0.9531
0.5000"	1/2"	0.0417	0.1250	0.2083	0.2917	0.3750	0.4583	0.5417	0.6250	0.7083	0.7917	0.8750	0.9583
0.5625"	9/16"	0.0469	0.1302	0.2135	0.2969	0.3802	0.4635	0.5469	0.6302	0.7135	0.7969	0.8802	0.9635
0.6250"	5/8"	0.0521	0.1354	0.2188	0.3021	0.3854	0.4688	0.5521	0.6354	0.7188	0.8021	0.8854	0.9688
0.6875"	11/16"	0.0573	0.1406	0.2240	0.3073	0.3906	0.4740	0.5573	0.6406	0.7240	0.8073	0.8906	0.9740
0.7500"	3/4"	0.0625	0.1458	0.2292	0.3125	0.3958	0.4792	0.5625	0.6458	0.7292	0.8125	0.8958	0.9792
0.8125"	13/16"	0.0677	0.1510	0.2344	0.3177	0.4010	0.4844	0.5677	0.6510	0.7344	0.8177	0.9010	0.9844
0.8750"	7/8"	0.0729	0.1563	0.2396	0.3229	0.4063	0.4896	0.5729	0.6563	0.7396	0.8229	0.9063	0.9896
0.9375"	15/16"	0.0781	0.1615	0.2448	0.3281	0.4115	0.4948	0.5781	0.6615	0.7448	0.8281	0.9219	0.9948
		0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"

Example: 1/8" = 0.0104' (column 3, row 3)
1-1/2" = 0.1250' (column 4, row 9)
8-11/16" = 0.7240' (column 11, row 12)